Gurnard, Hampshire

[SZ 462 943]

Introduction

Gurnard is a classic and internationally renowned site for both fossil insects and plants found within the Isle of Wight outcrop of the Bembridge Marls Member of the Bouldnor Formation within the Solent Group at the Eocene–Oligocene transition some 34 Ma (Figure 5.20). The site has attracted the attention of geologists since the middle of the 19th century with especial focus on the so-called 'Insect Limestone'. Fossils of some 220 insect species, several spiders and over 100 species of angiosperm plants and even a piece of lizard skin have been found, mostly within the 'Insect Limestone' and often with excellent preservation. Interpretation of fossils from the site provides important information on palaeoenvironmental and palaeoclimatic change in Europe at the Eocene–Oligocene transition. In addition, the 'Insect Limestone' within the Bembridge Marls preserves associations of both plants and insects.

Description

Stratigraphy

Along the northern shore of the Isle of Wight, from Gurnard south-westwards to beyond Burnt Wood, intermittent cliff and foreshore exposures of the Bembridge Marls occur on both limbs of the shallow Thorness Bay Syncline. The best exposures are around and to the south of Gurnard Ledge and to the north-west of Pilgrim's Park (see (Figure 5.22)).

Strata from the Osborne Marls Member in the upper part of the Headon Hill Formation to the 'Black Band' at the base of the Hamstead Member of the Bouldnor Formation occur here. However, the most palaeontologically significant sections are in the Bembridge Limestone Formation and lower part of the Bembridge Marls Member at the base of the Bouldnor Formation. The exposed sequence has a total thickness of less than 30 m. At Gurnard Ledge, the Bembridge Limestone Formation is 6.7 m thick and the overlying Bembridge Marls Member is 21.5 m thick (including the 'Insect Limestone', see section in (Figure 5.21)). The succession comprises mainly fine-grained clastic materials with black, grey and green muds, mostly characteristic of the Bembridge Marls Member, although marls do occur in places, especially lower down in the succession. Also, the 'Insect Limestone' is a very distinctive micritic limestone, just above the base.

The 'Insect Limestone' is exposed along a stretch of the Isle of Wight coast in Thorness and Gurnard Bay and has been shown to be a source of fossil plants for over a century with early records by Gardner (e.g. 1888). An early account of this bed with particular reference to the isopod crustaceans was made by Woodward (1879). However, much of our knowledge of the fossil flora and insects comes from the collecting activities of a local amateur and retired sailor James A'Court Smith who spent some 30 years amassing a collection of fossils from these beds. A more modern account of the isopods from the 'Insect Limestone' was undertaken by Martini (1972), and a major acount of the insect fauna was undertaken by Jarzembowski (1980a,b).

The name 'Insect Limestone' is something of a misnomer since it really consists of discontinuous concretionary limestones and hard marls within a predominantly argillaceous unit, although in places they develop into a tabular limestone up to 10+ cm thick. Within the limestones, which resemble some Purbeck micrites in lithology, the preservation of extremely delicate biological tissues and structures is facilitated by the exceptionally fine grain of the sediment. Unusually, the insects and the spiders are also preserved in three dimensions (see (Figure 5.24)), sometimes with details of their internal anatomy preserved in calcite. They are of taphonomic interest because the cuticle and colour patterns are preserved, the former as an aliphatic compound. It is this type of preservation that has recorded the presence of an unknown lizard in the fauna. A fragment of lizard skin with its characteristic scaly texture has been recently discovered in a private collection.

Palaeontology

Most of the fossils come from exposures immediately south of Gurnard Ledge, although the 'Insect Limestone' is also exposed on the southern side of the Thorness Bay Syncline.

Early references to the insect fossils were made by Smith (1874) but a major modern contribution has been made in recent decades by Jarzembowski (1976, 1980a,b).

The fossil insects (the entomofauna, (Figure 5.23)) comprise the largest insect fauna in the British Tertiary deposits, with some 15 orders represented, namely:

Odonata (dragonflies and damselflies, e.g. a damselfly — *Lestes* aff. *regina* Theobald, 1937, (Figure 5.23)h)

Plecoptera (stoneflies, e.g. *Leuctra priscula*) Blattodea (undescribed cockroaches)

Isoptera (termites, e.g. *Mastotermes anglicus* von Rosen, 1913, (Figure 5.23)q)

Orthoptera (crickets and locusts, e.g. a mole cricket — *Pterotriamescaptor primus* (Cockerell, 1921); (Figure 5.23)n)

Psocoptera (barklice, e.g. *Psocus acourti* Cockerell, 1921; (Figure 5.23)d)

Thysanoptera (thrips, e.g. *Aeolothrips brodiei* Cockerell, 1917; (Figure 5.23)k)

Hemiptera (bugs)

Carsidarina booleyi Cockerell, 1915; (Figure 5.23)c (a jumping plant louse)

Neuroptera (lacewings, e.g. '*Megalomus*' *tinctus* (Jarzembowski, 1980); (Figure 5.23)i)

Coleoptera (beetles, e.g. *Pterostichus gurnetensis* (Cockerell, 1921) — a ground beetle)

Mecoptera (scorpionflies, e.g. *Bittacus veternus* (Cockerell, 1921) — a hanging fly)

Diptera (true flies, e.g. a black fungus gnat — *Sciara lacoei* Cockerell, 1915; (Figure 5.23)a; a soldier fly — '*Odontomyia*' *brodiei* Cockerell, 1915; (Figure 5.23)f)

Trichoptera (caddisflies, e.g. *Beraeodes anglica* Cockerell, 1921; (Figure 5.23)p)

Lepidoptera (moths and butterflies, e.g. *Paratriaxomasia solentensis* Jarzembowski, 1980; (Figure 5.23)j)

Hymenoptera (ants and wasps, e.g. a weaver ant — *Oecophylla perdita* Cockerell, 1915; (Figure 5.23)b,m)

Two more have been found recently — an earwig (Dermaptera) and a praying mantis (Mantodea), bringing the total representation of presently known families to *c.* 167 (Ross, 2005). Of the insects examined by Jarzembowski, 70% belong to the Hymenoptera, Diptera and Coleoptera with more than 120 species belonging to the first two orders.

Other invertebrate macrofauna known from these strata include a variety of brackish to freshwater assemblages such as an anostracan crustacean (fairy shrimp — *Branchipodites vectensis* Woodward, 1879; (Figure 5.23)e) an isopod crustacean identified as *Eosphaeroma margarum* by Martini (1972); an ostracod *Potamocypris brodiei* (Jones and Sherborn) which has been compared with the freshwater genus *Cypridopsis* (Haskins 1968b); a spider *Eotypus woodwardii* (McCook, 1888, see below); freshwater gastropods *Galba* and the brackish water bivalve *Polymesoda.*

Finally, some rare fossil bird feathers have been found over the years since the 19th century (e.g. Brodie, 1878, Jarzembowski, 1980a,b) as well as the piece of lizard skin mentioned above, plus arthropod eggs and coprolites.

Spiders

Recently, Selden (2001b) has described a new fossil spider, *Vectaranaeus yulei* (Figure 5.25) and (Figure 5.26) and re-described the only previously described spider, *Eoatypus woodwardii* McCook, 1888, from the Insect Bed at this locality. Spiders are occasionally found (there are 50 specimens in the collections of the Natural History Museum, London) in this horizon and noted (Jarzembowski, 1976) but are rarely described. Like so many of the insects, the spiders occur in a massive fine-grained limestone resembling the lithology of the main tabular insect-bearing horizon. According to Selden (2001b) one spider-bearing block includes fragments of the reed *Typha,* hymenopterans, dipterans and juvenile araneans which might indicate a mass mortality or surface water aggregation.

The importance of these fossil spiders arises from the extremely fine preservation of their internal structures such as muscle fibres replaced by calcite and delicate structures such as tracheae, book-lung lamellae and spinnerets. Similar mineralization is also found in the fossil insect tissues. Selden's detailed analysis of these structures has shown that the wide, medially positioned, tracheal spiracle and large tracheae which enter the prosoma are adaptations for an amphibious mode of life. Apparently, *Vectaranaeus yulei* does not have specific adaptations for a fully aquatic mode of life. The three-dimensional preservation of such structures indicates that the fossils represent actual cadavers rather than moults.

Such an amphibious mode of life supports the evidence for the local habitat provided by sedimentology and associated biota with both aquatic (lacustrine) and terrestrial (woods, meadows and marshes) elements present. As Selden (2001b, p.721) writes, 'possibly, the Bembridge spider was aquatic and is preserved in its life habitat; however, it is likely that, under normal circumstances, an aquatic spider would be less prone to be killed by drowning than a terrestrial spider'. Nevertheless, the additional presence of other aquatic animals such as salinity-tolerant crustaceans and molluscs in the Insect Bed of the Bembridge Marls suggests that some abnormal conditions, such as change in salinity, was responsible for their death. This suggestion is reinforced by the presence of a locally abundant fairy shrimp, the extreme scarcity of fish and occasional pseudomorphs after halite in the 'Insect Limestone' and gypsum in the accompanying marls, all of which point to hypersaline conditions.

Plants

In addition, over 113 plant species; dominated by angiosperms, are known to occur here but not all have been described. Most of the macroplant fossils described by Reid and Chandler (1926) also originate from the 'Insect Limestone' with the majority coming from A'Court Smith's collection. The fossil flora accumulated in the 'Insect Limestone' has preferentially preserved wind-transported fruits and seeds with delicate wings or plumes. The remarkable preservation includes three-dimensional seeds of the free-floating aquatic plant *Stratiotes* some of which have been found with rodent gnaw marks on the tough seed coat in adjacent formations. The plants include aquatic species (such as the pond weeds — *Potamogeton pygmaeus* Chandler, 1925 and *Limnocarpus spinosus* Reid and Chandler, 1926; a bulrush — *Typha latissima* Al. Braun, 1851) along with climbers, herbs and rare remains of trees from the neighbouring forests and freshwater charophytes (Figure 5.23).

Detailed analysis of the flora by Collinson *et al.* (1993) showed that the Bembridge Limestone was formed in carbonate-rich ponds or lakes within relatively arid surrounding landscapes. By contrast, the Bembridge Marls represent marshlands with more immediately adjacent woodlands which may have resulted from temperature fluctuation during deposition. The assemblage shows marked changes in both aquatic and forest floral components from earlier British Tertiary records. The decline in the tropical-subtropical elements of the Bembridge Marl flora gives dear indications of overall cooling climate.

The significance of the fossil insects

The quality of preservation, abundance and diversity of the fossil insect fauna and its accompanying flora make the 'Insect Limestone' at Gurnard the palaeoentomologically most significant site in the Palaeogene deposits of southern England. The insect fauna is the largest of the British Tertiary and contributes significantly to our understanding of contemporary environments. The presence of three or four families of termites supports the interpretation of the palaeoclimate derived from the fossil plants as being indicative of a climate warmer than today and was probably close to that of the warm-temperate (subtropical) to tropical boundary. Machin (1971) suggested a comparison with present-day

Florida. Jarzembowski (1980a) mentions the presence of one termite genus, *Mastotermes,* which is thought to be indicative of slightly wetter conditions than found in modern subtropical rain forests as today it is only found around Darwin in the Northern Territory of Australia and New Guinea.

Most of the insects are from terrestrial habitats and the rarity of aquatic, freshwater insects led Jarzembowski to suggest that there was only a limited development of freshwater habitats. However, Daley (in Daley and Balson, 1999) suggests that such an interpetation is incompatible with macrofossil studies on the Bouldnor Formation as a whole '...from which the widespread existence of marshes, sluggish rivers and lagoons has been inferred. Nor is it consistent with the presence of water plants like *Typha* and *Potamogeton* in the 'Insect Limestone' itself'. However, it can also be argued that as the 'Insect Limestone' is a unique deposit, interpretation could be quite different, especially as the plants are not rooted but fragmentary and probably derived from elsewhere.

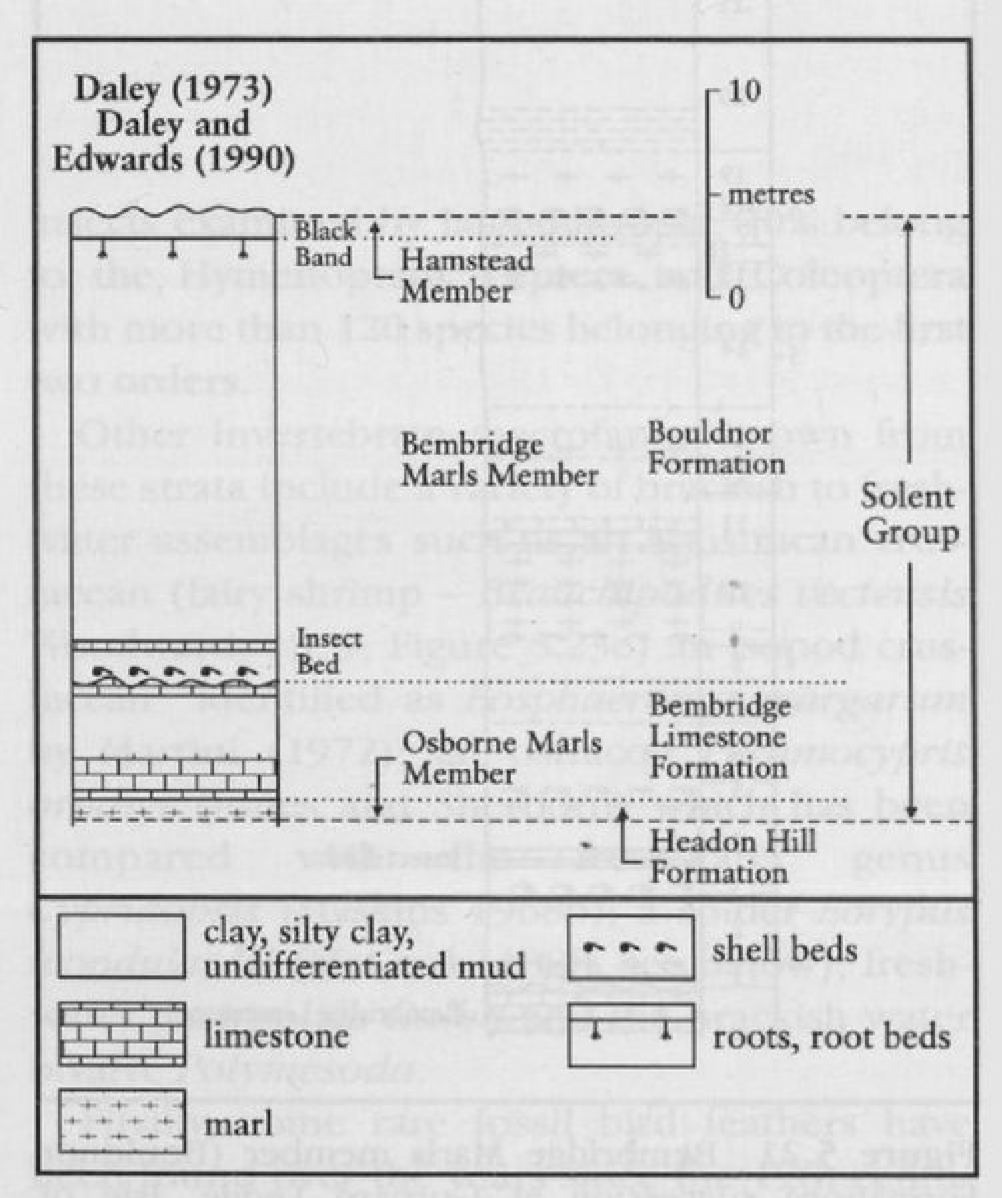
Palaeoenvironmental interpetation

Interpretation of the sedimentology of the Bembridge Marls Member of the lower part of the Bouldnor Formation suggests that deposits were brackish to freshwater sediments laid down under relatively shallow and quiet-water depositional conditions. The palaeontology supports such a view so that overall there were essentially regressive conditions of deposition with fluctuating salinity. Deposition was within a sluggish estuary or lagoon with extensive and persistent marshland with some open waters, wooded islands and fluvial influences whose salinity varied according to the extent of the marine or climatic influence.

Conclusions

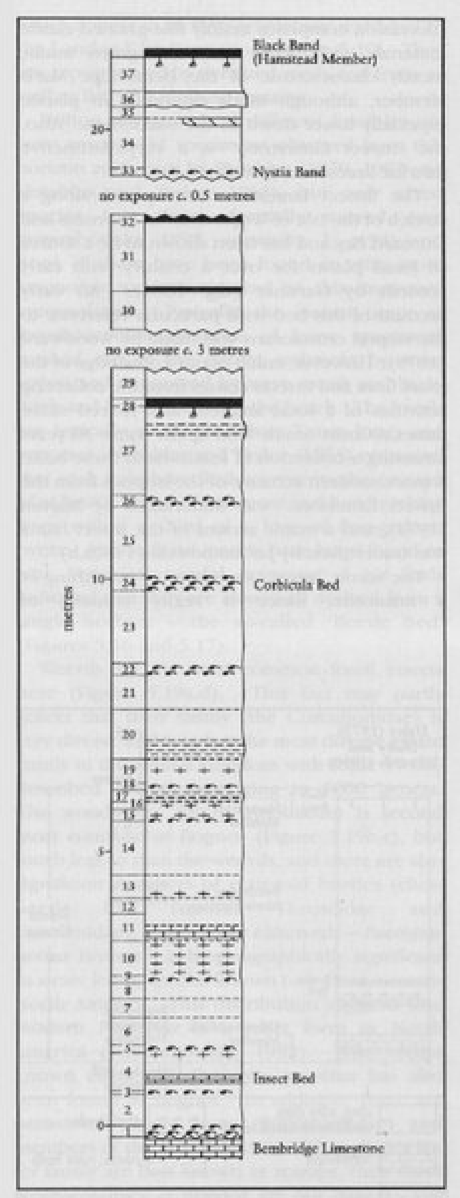
The sedimentary succession at Gurnard and Thorness Bay preserves the most important insect fauna in the British Palaeogene derived from deposits at the Eocene–Oligocene Transition (33.9 Ma). The abundant and unique association of insect and plant fossils from the 'Insect Limestone' in the Bembridge Marls Member is particularly important for the understanding of the environmental history of Britain during the Palaeogenc Period with its associated global climatic cooling. Gurnard is part of a network of late Eocene/early Oligocene GCR sites (see also GCR site reports for St Helens and Bouldnor) in the Hampshire Basin.

References

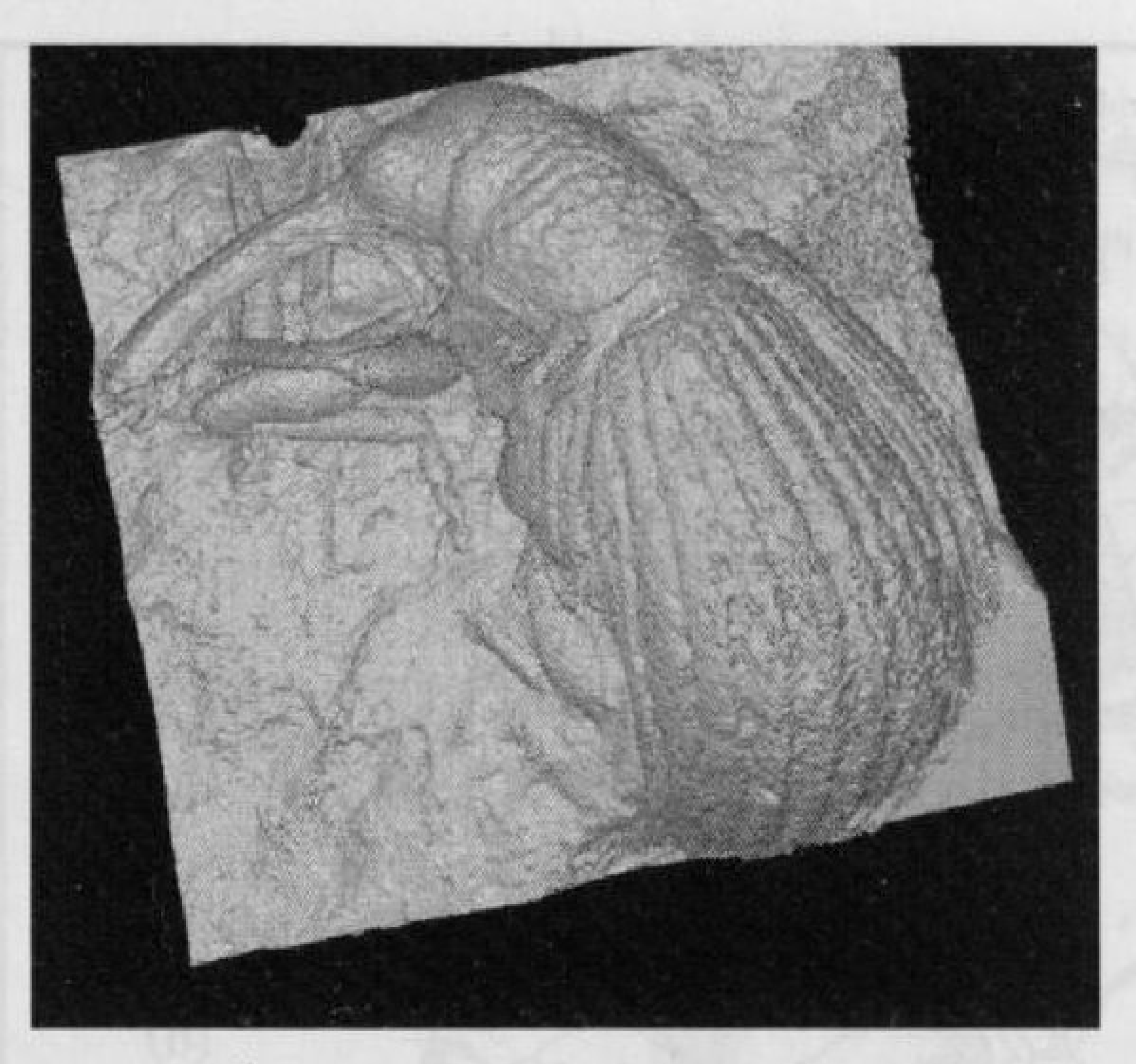


(Figure 5.20) Stratigraphical succession at Thorness Bay, Isle of Wight. (After Daley and Balson, 1999, fig. 5.43.)

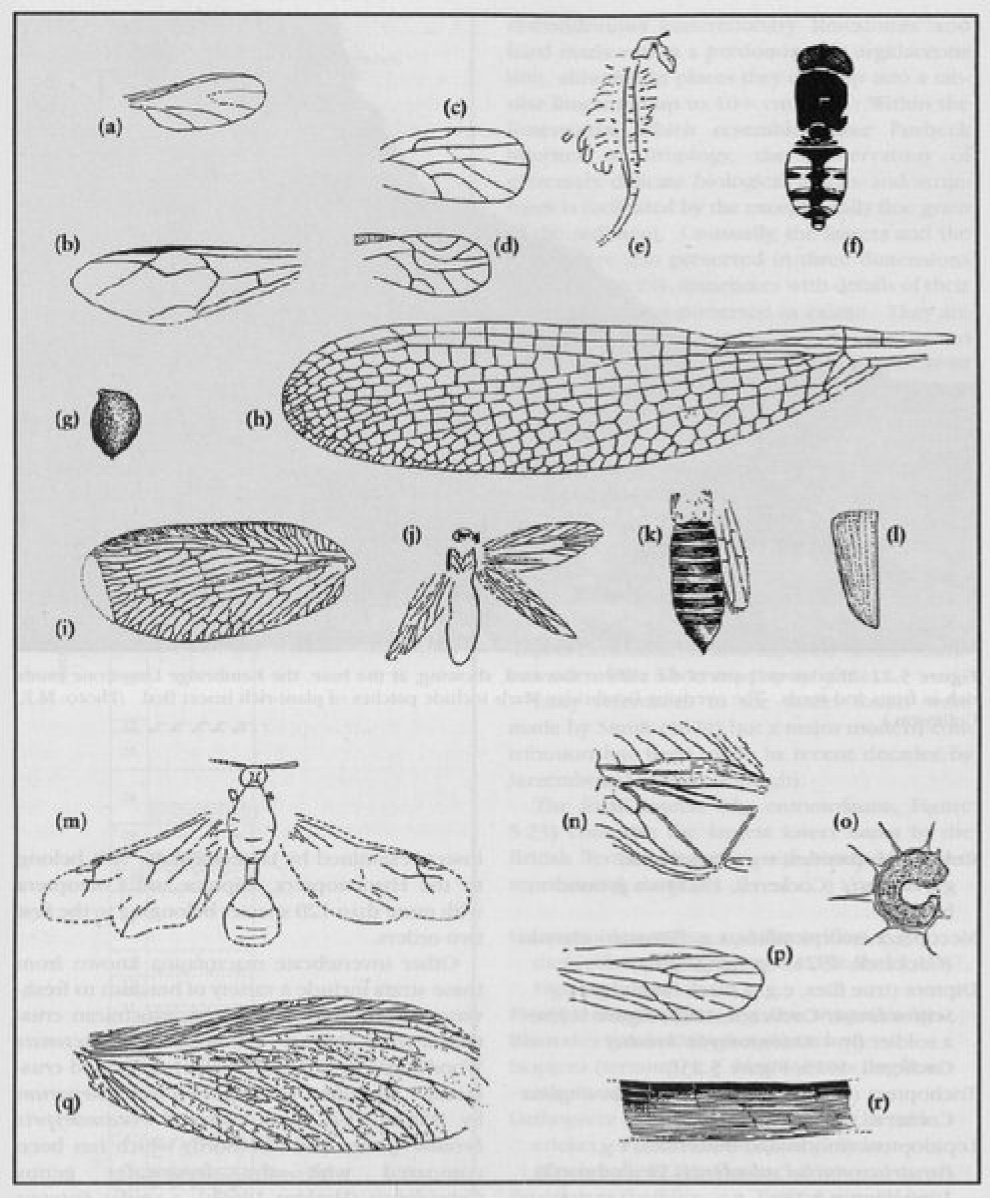
(Figure 5.22) The lowest parts of the cliffs at Gurnard, showing, at the base, the Bembridge Limestone muds rich in fruits and seeds. The overlying Bembridge Marls include patches of plant-rich Insect Bed. (Photo: M.E. Collinson.)



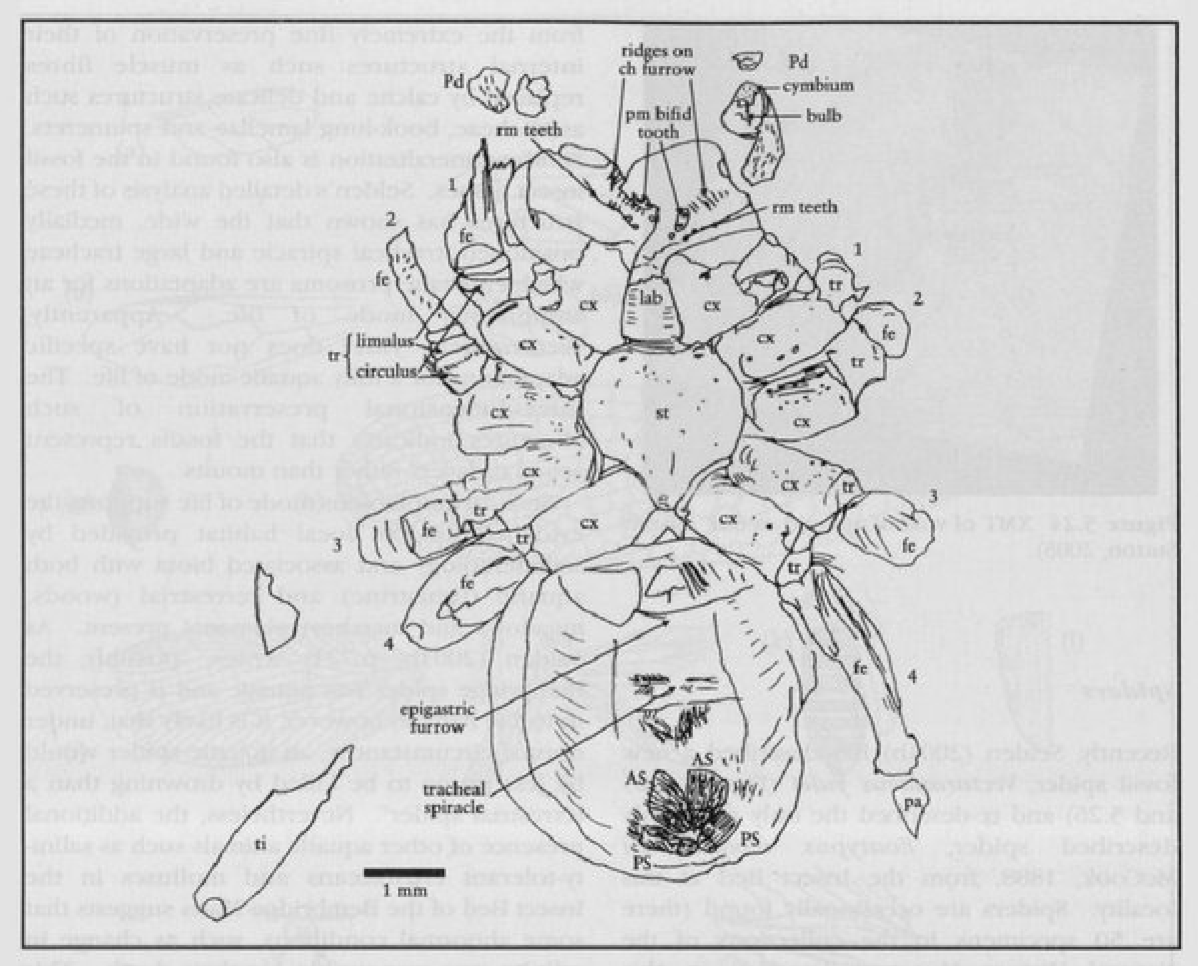
(Figure 5.21) Bembridge Marls member (Bouldnor Formation) succession at Gurnard Ledge, Isle of Wight. (After Daley, 1972.)



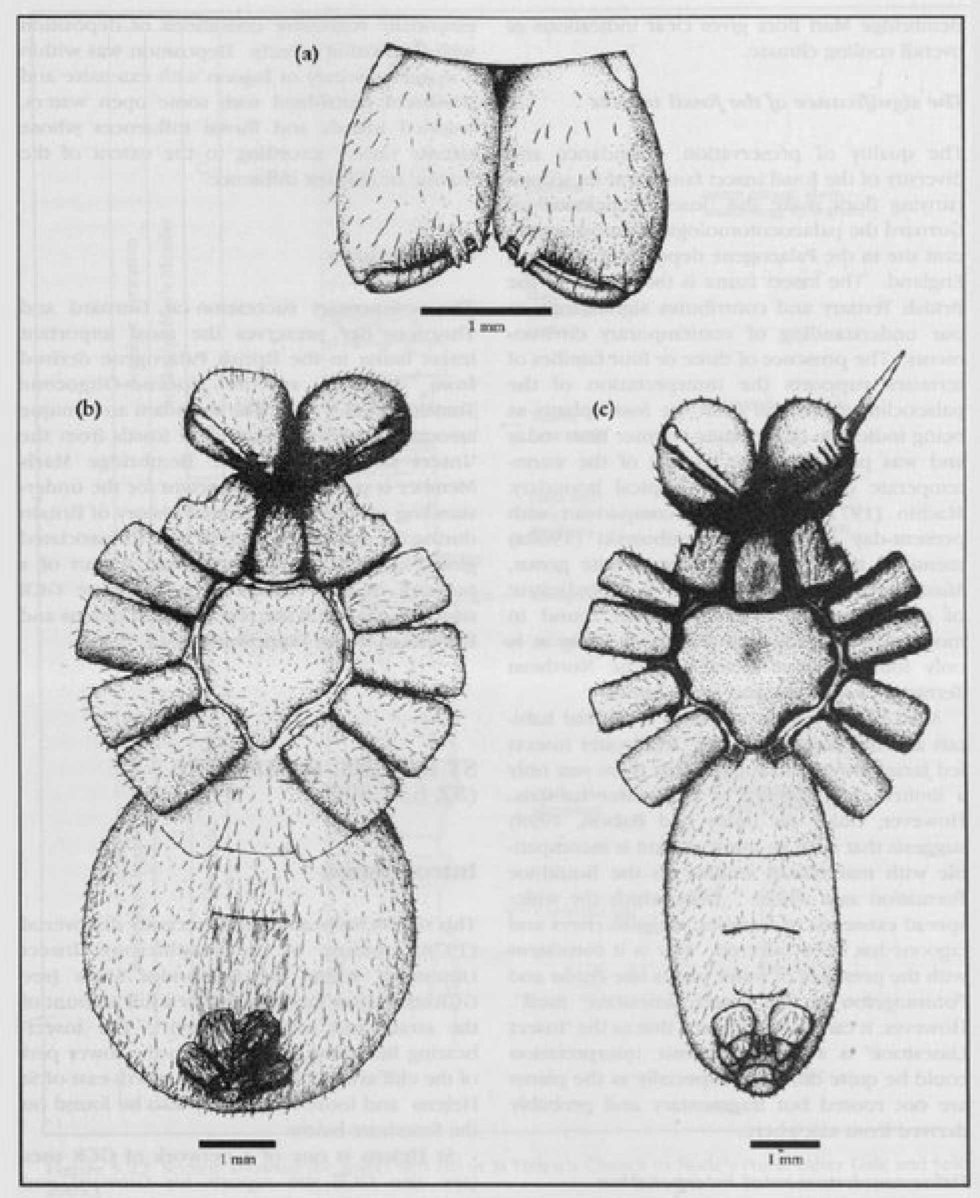
(Figure 5.24) XMT of void of apionid weevil. (From Sutton, 2008).



(Figure 5.23) (a) Sciara lacoei (Cockerell, 1915) (Diptera: Sciaridae). Forewing 1.6 mm long. Black fungus gnat. (b) Oecopbylla perdita (Cockerell, 1915) (Hymenoptera: Formicidae). Forewing 12.8 mm long. Weaver ant. (c) Carsidarina booleyi (Cockerell, 1921) (Hemiptera: Carsidaridae). Forewing 3mm long. Jumping plant louse or psyllid. (d) Psocis acourti (Cockerell, 1921) (Psocoptera: Psocidae). Forewing 3mm long. Bark or book louse. (e) Branchipodites vectensis Woodward, 1879 (Anostraca: Branchipodidae?). Length 5mm. Fairy shrimp. 'Odontomyia' brodiei (Cockerell, 1915) (Diptera: Stratiomyidae). Male, 11.5mm long. Soldier-fly. (g) Limnocarpus spinosus (Reid and Chandler, 1926) (Monocyotyledones: Potamogetoneae?). endocarp, 1 mm long. 'Stiff' pondweed. (h) Lestes aff. regina (Theobald, 1937) (Odonata: Lestidae). Forewing, 22 mm long. Damselfly. (i) 'Megalomus'tinctus Jarzembowski, 1980) (Neuroptera: Hemerobiidae). Forewing 5 mm long. Brown lacewing. (j) Paratriaxomasia solentensis Jarzembowski, 1980 (Lepidoptera: Tineidae). Wingspan 8 mm. Moth. (k) Aeolothrips brodiei Cockerell, 1917 (Thysanoptera: Aelothripidae). Length 1.3 mm. Thrip. (1) Undescribed weevil (Coleoptera: Curculionoidea). Elytron 5.7 mm long. Hamstead Beds. Beetle. (m) Oecophylla cf. perdita Cockerell, 1915 (Hymenoptera: Formicidae). Wingspan 27 mm. (n) Pterotriamescaptor primus (Cockerell, 1921) (Orthoptera: Gryllotalpidae). Forewing fragment 6.5 mm long. Mole cricket. (o) Potamogeton pygmaeus Chandler, 1925 (Monocotyledones: Potamogetonaceae). Fruit, maximum diameter 2 mm. Pond weed. (p) Beraeodes anglica Cockerell, 1921 (Trichoptera: Beraeidae). Forewing 4.5 mm long. Caddisfly. (q) Mastotermes anglicus von Rosen, 1913 (Isoptera: Mastotermitidae). Forewing 22 mm long. Termite. (r) Typha latissima Al. Braun, 1851 (Monocotyledones: Typhaceae). Leaf fragment 45 mm long. Bulrush (Cattail U.S.A.). (From Jarzembowski, 1999a.)



(Figure 5.25) Vectaraneus yulei gen. et sp. nov., upper Eocene, Bembridge Marls, Isle of Wight. Drawing of paratype, IWCMS 1999.6. cx: coxa; tr: tochanter; pa: patella; fe: femur; ti: tibia; rm: retromarginal; pd: pedipalp; ch: chelicera; pm: promarginal; lab: labium; st: sternum; ti: tibia; pa: patella; AS/PS anterior/posterior spinneret. (From Selden, 2001b.)



(Figure 5.26) Vectaraneus yulei gen. et sp. nov., upper Eocene, Bembridge Marls, Isle fo Wight. Reconstruction of (a) chelicerae, anterior view, and (b, c) body, ventral view (b, female and c, male). (From Selden, 2001b.)